CEMENT AND LIME MANUFACTURE

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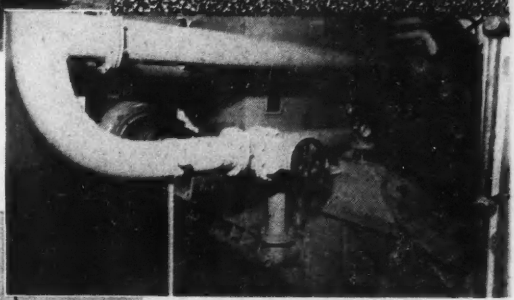
M.V JOHN WILSON
Built by Henry Robb Ltd. for Wilsons Portland Cement Co (New Zealand) Ltd

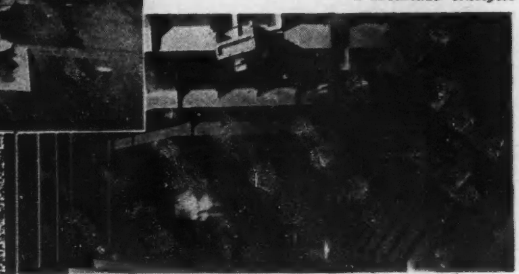
Upper deck showing cement discharge pipes and loading hatch with control gear



Two 10" F-K pumps discharging to shore silos

TO SHORE

A cement hold showing distribution and extraction by "F-H Airslide" conveyors



BY FULLER EQUIPMENT BULK CEMENT MOVES THE EASY WAY

Whenever bulk cement needs to be loaded or unloaded, whatever the route, whatever the problem, there is a Fuller system which will satisfy the most stringent requirements. This installation we have recently completed on the new MV John Wilson utilises * "F-H Airslide" conveyors and Fuller-Kinyon pumps to provide the most efficient and economical method of loading and unloading bulk cement. We will be pleased to study any cement handling problem you may have.

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Ship for Transporting Cement.

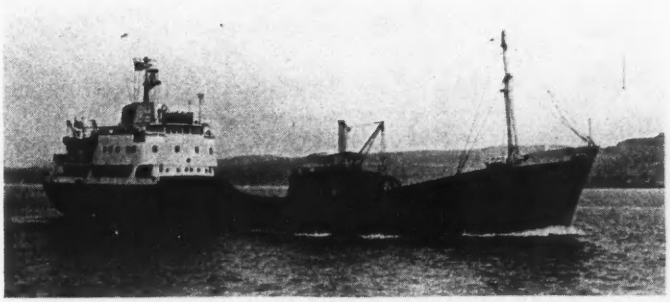


Fig. 1.

A NEW 1800-ton sea-going vessel, M.V. " John Wilson " (*Fig.* 1) for transporting cement in bulk was constructed in this country for Messrs. Wilsons (N.Z.) Portland Cement Ltd., New Zealand. The vessel, which has a capacity of 1750 tons of cement, has an overall length of 270 ft. In common with most bulk carriers, the engine and machinery, other than cement-handling machinery, are in the stern. The ship is of welded-steel construction, framed longitudinally, the framing being specially designed to accommodate " Airslide " conveyors for fluidising the cement. The double bottom, which is of cellular construction, is used for carrying water as ballast. Propelling power is provided by three diesel-electric motors, two of which are connected to the cement-handling machinery for loading or unloading the cement.

The two holds, one fore and one aft, are divided longitudinally by a tunnel

running throughout the length with a corrugated bulkhead above the tunnel. Generally the cargo will consist of two grades of cement. The capacity and positions of the holds are designed to suit the trim of the vessel when loading and discharging. Machinery for handling the cement is installed in a separate space situated amidships between the forward and after holds. There are no hatchways to the holds, other than access and inspection hatches, and cement is loaded at two points arranged centrally over each hold. The loading plant on shore is connected up by means of telescopic pipes, and cement is distributed throughout the holds by " Airslide " conveyors. The telescopic loading chutes and flexible hoses provide for tidal fluctuations and variations of draught during loading and unloading. The equipment permits cement to be unloaded at the rate of 280 tons per hour direct to storage silos ashore at a horizontal distance of 600 ft. and a height of 100 ft.

Loading.

The cement is conveyed from the hoppers on shore through the " Airslide "

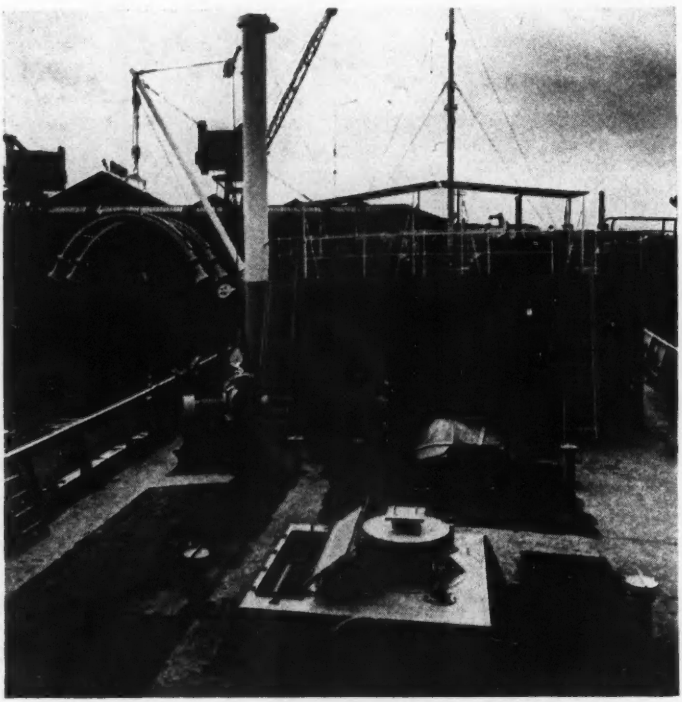


Fig. 2.

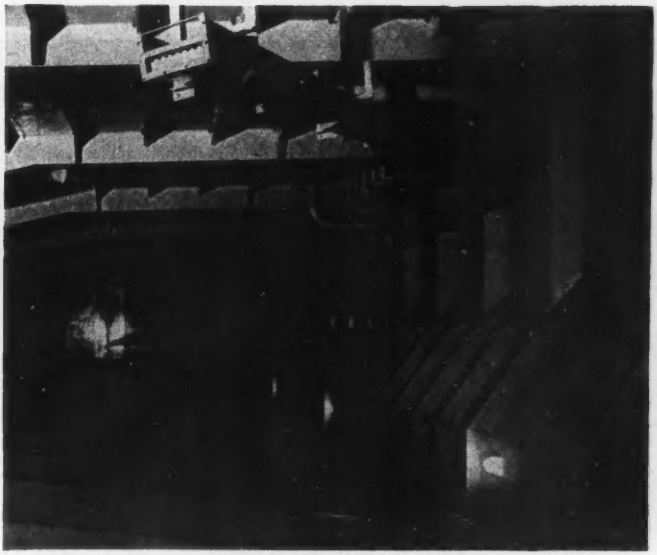


Fig. 3.

conveyors and telescopic chutes to the aerated distribution boxes installed on the deck at the centre of each hold (*Fig.* 2). Each box has a base of porous fabric with an air-chamber below. The base is below the deck and four " Airslide " conveyors radiate from the distribution box towards each corner of the hold (*Fig.* 3). Gates at the outlets of the box control the rate of flow; the controls extend beneath the deck and rods indicate the position of each gate. In this type of conveyor air is passed through a porous, rot-proof cotton fabric woven to give the desired permeability. The fabric forms the upper side of an air-chamber and the uniformity of the weave ensures that air emerges uniformly over its entire area. The cement is fluidised by the infiltration of air and, since the plane of the porous medium is inclined sufficiently, the fluidised cement flows down the slope.

There are two main types of " Airslide " conveyor in use in the vessel, an open type and a closed type. The open type consists of an air-chamber covered by fabric and is installed at the bottom of the holds. The closed type has a duct in the shape of a top hat above the fabric and is used for conveying the cement from fluid lifts to pump hoppers. An intermediate type of conveyor is provided with side plates 3-in. high and this is used to distribute the cement throughout the holds when loading. The cement flows along the conveyor towards a corner of the hold where it is deposited, surplus material spilling over the plates into the hold. The last area of the hold to be filled is therefore that immed-

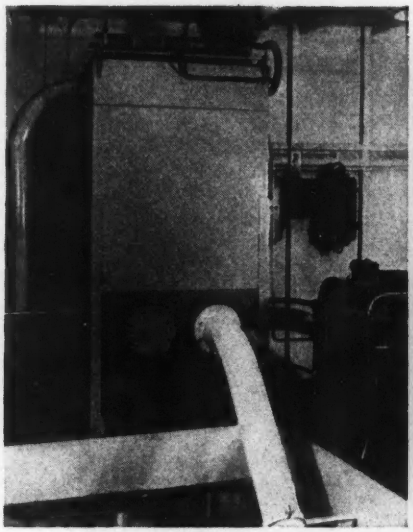


Fig. 4.

Fig. 5.

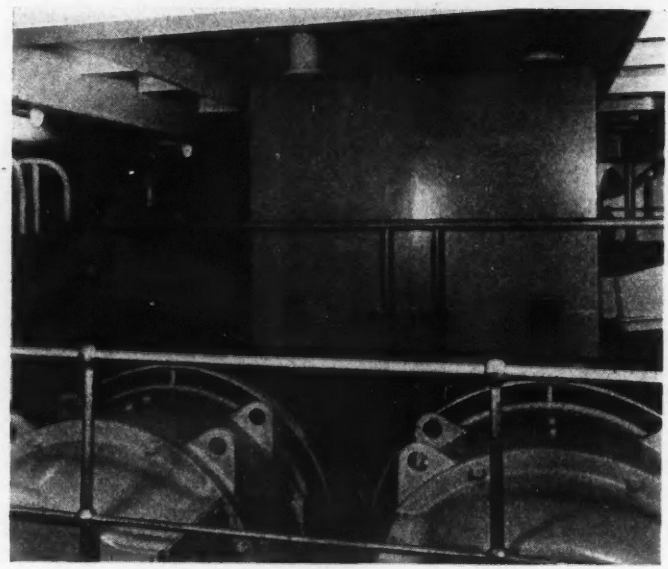


Fig. 7.

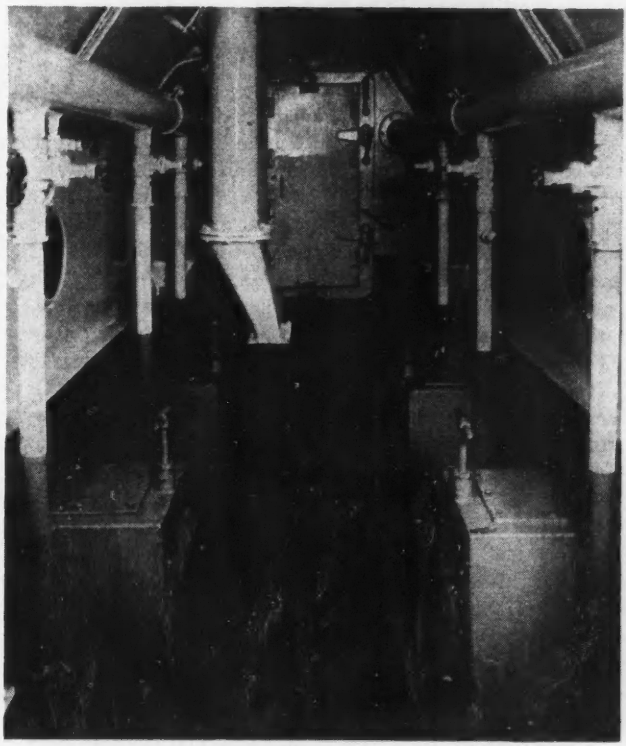


Fig. 6.

iately below the central distribution boxes. The trim of the vessel is controlled by adjusting the flow-gates and, if loading is to be speeded up, by opening the ports in each distribution box.

The air supply to the " Airslide " used for loading is provided by fans working from the ship's auxiliary generator. Air is entrained in the cement flowing into the hold and, as the cement settles, the air and fine dust is withdrawn from the hold through a pipe of such diameter that the velocity of the escaping air is sufficient to prevent dust being deposited. The pipe is connected to an automatic dust collector in the control space amidships. The dust collector is shown at the top in *Fig.* 4 connected to the pipe. The air is drawn through the dust collector by a fan which maintains a slight suction in the holds. The filter sleeves in the dust collector are cleaned by a compressor which delivers, to each sleeve in turn, a blast of air in the opposite direction to the flow of the dust-laden air. The

compressor is shown on the right in *Fig.* 4. The cleaning sequence is controlled by an electrical timer.

Unloading.

A 5-ton derrick crane adjacent to the control room (*Fig.* 2) is used to swing the hoses for the cement into position. When discharging, the cement is fluidised by the open type " Airslide " conveyors at the bottom of each hold, and continuous flow is maintained by settlement from above. This delivers the cement to the screw-conveyor (*Fig.* 5) installed in the central tunnel between the holds. At the end of the screw-conveyor, the cement is fluidised so that it rises through a vertical duct (*Fig.* 6), and at the same time is displaced by cement following it, to a further " Airslide " conveyor of the closed type which delivers it to the surge hopper above two pumps (*Fig.* 7). The hopper has a central division so that each of the holds generally serves the adjacent pump, but provision is made for either hold to serve either pump. Entrained air is separated by the dust collectors used when loading. Below the divided surge hopper the two 10-in. pumps receive the cement and, in conjunction with air delivered by two pairs of rotary compressors, convey it to storage silos ashore through 10-in. steel pipes and flexible hoses between the ship and quay. All machinery is electrically operated using a d.c. supply which permits the speed of the screws and pumps to be regulated thus enabling the rate of dischage to be controlled.

The vessel was built at Leith by Messrs. Henry Robb Ltd. The main equipment for handling the cement was supplied by Constantin (Engineers) Ltd., and comprises " F-H Airslide " fluidising conveyors working in conjunction with Fuller-Kinyon pumps.

The Constitution of the Expansive Agent in Expanding Cement.

THE expansive agent in expanding cements has been described by Lafuma as sulpho-aluminous clinker produced by burning a mixture of gypsum, bauxite and calcium carbonate. In this clinker free anhydrous calcium sulphate 5 CaO . $3AL_2O_3$ and γ-2 CaO . SiO_2 has been identified, but the presence of calcium sulpho-aluminate was not confirmed. In the Bulletin of the Chemical Society of Japan, January 1961, N. FUKUDA reported an investigation of clinkers of this nature using X-ray diffraction patterns by the powder-method and quantitative X-ray analysis using standard substances.

Mixtures of bauxite, lime and gypsum were heated for thirty minutes at 1350 deg. C. giving clinkers similar in appearance to that described by Lafuma. By varying the proportion of gypsum, clinkers with the mole ratios of Al_2O_3/SO_3 of 8·2, 6·0, 3·5, 2·0 and 0·8 were prepared.

The existence of 3 CaO . $3Al_2O_3$. $CaSO_4$ was definitely established as the main constituent of the clinkers. The amounts of this constituent as determined by chemical analysis and by quantitative X-ray analysis were in fairly good agreement; when the mole ratio Al_2O_3/SO_3 was less than 3·0, the amount was equivalent to the proportion of Al_2O_3, and when more than 3·0, the amount was equivalent to the proportion of SO_3.

Water Content of Slurry Reduced by Additives.

IN an article by T. STOIJANOV, of Bulgaria, in "Stroitelni materiali i silikatna promischlenost," No. 4, 1960, attention is drawn to the large amount of constructional work being carried out in Bulgaria. The consequent demand for cement is considerable. Cement works are being enlarged, and attempts are being made to improve the productive efficiency of the kilns, one means of so doing being by lowering the water content of the slurry fed into the kiln by means of additives. This method avoids the large capital outlay necessary for mechanical methods. Sodium silicate is generally used as an additive, but tests have also been made with sodium carbonate and sodium-lignosulphonate powder. The addition of

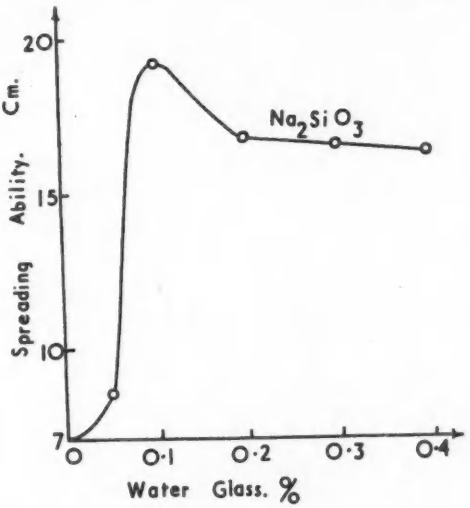


Fig. 1.

sodium silicate has a marked effect on the flowability and the ability to retain water, and tests are continuing with this material in preference to the others.

The reason for the improvement is not completely known but it has been ascertained that the water content of the raw materials is now 24 per cent. which is 11½ per cent. lower than normal. From the diagram in *Fig.* 1 it is seen that the best results are obtained with the addition of 0·1 per cent. of sodium silicate (water glass) by weight of the dry materials. The sodium silicate is added to the water rather than to the dry materials. With 76 per cent. of solids and 24 per cent. of water in the final mixture, the optimum concentration of sodium silicate in the water is therefore 0·32 per cent. Laboratory control must be exercised

during the preparation and use of the sodium-silicate solution, but this is not regarded as a serious disadvantage.

The output of cement clinker has, in one case, increased by 15 per cent., or 58,000 tons per annum, by using a very economical amount of sodium silicate and it is hoped by this means to increase production further.

The Efficiency of Lime Kilns.

THE burning efficiency of lime kilns and discussions on refractories and fuels for rotary and shaft kilns were dealt with at the annual meeting, held in 1960, of the Operating Division of the National Lime Association of America as recorded in "Rock Products."

Refractories are now available to suit the users' requirements and the use of dams and special refractory arrangements within the kilns is well established. A uniform useful life of the refractories in all parts of a kiln is now possible. The next step is to improve the quality of the refractories and thereby increase production of lime for a longer period without maintenance of the refractories. With the inclusion of quadrant and trefoil heat-exchangers and improved methods of insulation, temperatures up to 2600 deg. F. are permissible within the kilns.

The superiority of coal over other fuels for rotary kilns was discussed, although it was stated that one of the disadvantages was that rings of ash tend to form just beyond the end of the combustion zone in the kiln. The method employed by one company for removing the rings is to admit cold air to the chamber for five to fifteen minutes at every eight-hour shift. Although the kiln loses about three hours of production time every 96 hours, compared with only one and a half hours if "shooting" the rings is adopted, the savings in kiln-gun shells is considerable, the number decreasing from 31,000 shells annually in 1956 to 3000 in 1959. Further developments suggested included the provision of a travelling grate preheater, which type of equipment has proved so efficient in a Danish lime works that production was greatly increased while thermal requirements were reduced from 8,600,000 to 5,700,000 B.t.u. per ton of lime.

The efficiency of shaft kilns and the importance of the conversion of kilns to oil-firing in several European countries where oil is more economical than other forms of fuel were considered. The success of such a conversion depends on the design of the chambers spaced radially around a kiln which is burning preheated oil. The gaseous mixture of hydrocarbon burns deep within the charge of stone to produce lime with exceptional thermal efficiency.

A British Kiln.

DR. G. E. BESSEY, of The Chalk, Lime & Allied Industries Research Association (of Great Britain), described the Brockham kiln that is useful only for burning chalk. A mixture of lime and coke is introduced into a narrow flue about 5 ft. diam. where moisture from the chalk is evaporated as the coke burns. Then the preheated dried material works its way downward into a bell-shaped firing chamber where coal is added to complete calcination reaction. The finished lime is drawn through air-operated gates.

A New Type of Elutriator for Fine Powders.

IN "Zement-Kalk-Gips" for May 1960, MR. K. HOFMANN-DEGEN describes a method for separating particles of different sizes of cement and other powdered solids within the range from 50 microns down to fractions of a micron. The method employs elutriation by liquid with a special system for maintaining the particles in a state of deflocculation while those exceeding a certain predetermined size are removed.

The main part of the apparatus (*Fig.* 1), which is of patented design, consists of a vertical glass cylinder, 40 cm. in height and 7 cm. in diameter, shaped like a large reaction-tube, with a glass tube fused into the side near the top to act as an overflow. A closed head-piece is cemented over the top of the cylinder. The upper part of the head-piece can be disconnected at a junction which is sealed by a soft rubber ring. A narrow glass tube passes through bushes in the upper part of the head and down the centre of the large cylinder, and is free to slide axially. The bottom end of the tube is fixed in a hole through the axis of a sphere which almost fills the width of the cylinder, leaving only a small clearance. Inside the movable tube there is a fixed tube which reaches to the bottom of the cylinder and which can be adjusted accurately in the axis of the cylinder by means of thumb-screws at the junction. Thus the sphere can be moved freely up and down (by levers connected to a motor) without touching the wall of the cylinder. The apparatus includes an arrangement for passing liquid down the central tube, up through the cylinder and out of the overflow at constant velocities in the cylinder between 1 cm. per minute and 1400 cm. per minute.

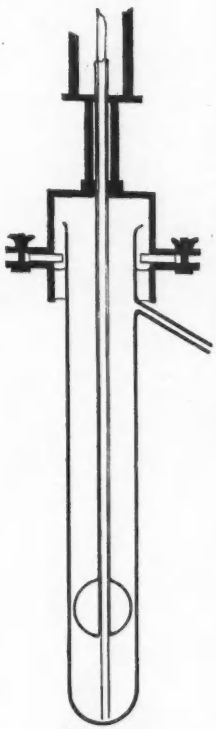


Fig. 1.

Suspended particles carried out of the overflow are collected and weighed in a curved tube in which the final separation from the elutriating liquid is carried out by distillation. When the sphere is given a periodic up-and-down motion at a certain distance below the surface of the liquid in the cylinder, the liquid flowing round the sphere is powerfully agitated. Since the bottom of the cylinder is hemispherical, the sphere fits closely into it and allows no sediment to collect.

The turbulent zone created by the high velocities through the annular space takes the form of a vortex and is almost independent of the relatively slow overall upward flow of the liquid in the cylinder. Above the turbulent zone, the upward flow in the cylinder becomes strictly laminar. In the apparatus the movable tube connected to the sphere is encased in another tube reaching down to the upper

limit of movement of the sphere so that the laminar flow is not disturbed. When the apparatus has been in action for some time with a powder suspended in the liquid, a very narrow third zone becomes visible between the turbulent zone and the zone of laminar flow. This third zone behaves like an independent structure consisting of a thin cloudy disk of very pale colour, only a few millimetres in thickness, swinging slightly on the top of the vortex.

In the course of time as the smallest particles are removed from the suspension, the narrow band loses its cloudy appearance and takes on a silken lustre. It retains its boundaries in spite of the upward flow of the elutriating liquid through it. It appears that a considerable degree of preliminary separation of the finer particles occurs in this narrow band.

In order to remove particles below a certain size, the velocity of the elutriating liquid is set at an appropriate value as calculated by the Stokes formula. A quantity of powder is used such that in the relevant volume of liquid the process of separation is relatively unhindered by interference between particles.

The distribution of the sizes of particles given by the elutriator for three types of Portland cements, ground in different types of mills, was compared with the results for the same cements obtained by sedimentation using the Andreasen pipette after shaking for ninety minutes. The liquid used was methanol which had been boiled over quicklime for twenty-four hours. The misleading result caused by flocculation occurring in the sedimentation process was consistently demonstrated. The results given by the elutriator showed far greater fineness and less variation at the extremes. With a relatively coarsely ground cement, a curve plotted from the results given by the elutriator ran almost straight into the curve obtained by a sieve analysis of the particles up to 200μ, but a curve based on the sedimentation test did not do so. The percentage by weight of particles below 1 micron in diameter determined by the elutriator was from two to six times as great as that determined for particles below 2 microns by sedimentation, and in one case the value for particles below 2 microns obtained by elutriator was nine times that obtained by sedimentation. The total percentages of particles from 0-50 microns given by the elutriator were nearly double those given by sedimentation.

A British Standard for Refractory Bricks.

A NEW British Standard, B.S. 2973 (1961), "Classification and Methods of Sampling and Testing of Insulating Refractory Bricks," which was issued recently, covers the classification and methods of sampling and testing of insulating refractory bricks for temperatures of not less than 1100 deg. C. The bricks are classified in accordance with the following temperatures at which the permanent linear change does not exceed 2 per cent.;—1100, 1250, 1350, 1450, 1500, and 1550 deg. C., and thereafter in increments of 50 deg. C.

The tests include measurement of dimensions, details of warping (that is convexity and concavity), determination of the bulk density of dried bricks, permanent linear change upon heating, the crushing strength of a cold brick, the modulus of rupture, and the thermal conductivity.

Volumetric Determination of Sulphite Lye in Cement and Slurries.

THE use of sulphite lye as a diluent for slurries and as a plasticiser for cements has become widespread in recent years. The active ingredient in sulphite lye is calcium lignosulphonate but natural sugars are also present in the unrefined material. A method has been developed for controlling the addition of sulphite lye to cements and slurries which depends on the volumetric determination of sugars in the lye and also in aqueous extracts from the treated slurries or cements.

The method is based on oxidation of the sugars by a potassium-ferricyanide solution in an alkaline medium. The reaction which is quantitative after several minutes heating is

$$C_6H_{12}O_6 + 6KOH + 6K_3Fe(CN)_6 = (CHOH)_4 + (COOH)_2 + 4H_2O + 6K_4Fe(CN)_6.$$

In a practical determination, excess standard potassium-ferricyanide solution and potassium-hydroxide solution are added to an aqueous solution of the lye or test sample. The excess potassium ferricyanide present after oxidation is estimated by iodimetry in a slightly acid medium:

$$2K_3Fe(CN)_6 + 2KI \rightleftharpoons I_2 + 2K_4FE(CN)_6;$$

$$I_2 + 2Na_2S_2O_3 = 2NaI + Na_2S_4O_6.$$

The reaction with potassium iodide proceeds quantitatively in the presence of a zinc salt.

Insoluble potassium zinc ferrocyanide is formed according to the reaction

$$2K_4FE(CN)_6 + 3ZnSO_4 = K_2Zn_3\}Fe(CN)_6\{_2 + 3K_2SO_4.$$

The zinc salt also has another function since it precipitates zinc sulphide from solutions prepared for test from slag cements. Cements with up to 15 per cent. of slag can be examined by this method without interference by the sulphides present.

From a knowledge of the sugar contents of the sulphite lye and the sample of cement or slurry, it is possible to estimate the sulphite lye present in the sample to an accuracy of 0·03 per cent.

The foregoing information is abstracted from a Russian publication, "The Physico-mechanical and Physico-chemical Examination of Cement." The use of calcium lignosulphonate to reduce the water required in the slurry at a works employing closed-circuit grinding and the flotation process was described in this journal for September 1957, and was derived from a German source.

Detection of Weaknesses in Kiln Linings.

THE instrument shown in *Fig.* 1 is a radiation pyrometer which slides along two steel wires stretched lengthwise along the hot zone of a kiln at the works of the Universal Atlas Cement Corp., at Gary, Indiana, U.S.A. The apparatus

Fig. 1.

detects positions where the kiln casing is excessively hot so that the operator is warned before damage occurs. It is claimed that much of the time formerly spent in replacing refractory linings is now saved; a kiln could be out of use for as many as five times in a period of nine months when temperature-sensitive crayons were used, whereas it has been only once out of commission with the new apparatus. A continuous signal is returned by the apparatus to an electronic recording chart. If the temperature at any part exceeds a predetermined degree, warning is automatically given to the kiln manager or to the burner-operator.

A New Dry-process Works in U.S.A.

In the article entitled "A New Dry-process Works in U.S.A.", in the number of this journal for May 1961, it is stated that the works were designed and built by Messrs. George A. Fuller Co. We have been informed that the equipment including the horizontal grate-cooler, the clinker breaker, the "Airslides" and pneumatic conveyors, and the compressors was supplied by the Fuller Co., Catasauqua, Pa., U.S.A.

Cement Industry Abroad.

Near East.

Iran.—The Tehran Cement Co. is to establish a cement works thirty miles from Tehran. The new works is intended to have a capacity of 600 tons per day. The Company's other works, which is in Tehran, also has a capacity of 600 tons per day.

The Dorud cement works has been acquired by the Fars Cement Co. It is reported that the sale of the Looshan cement works is also contemplated.

The index of the production of cement in the year ending March 1960 was 257, the index for 1956-57 being 100. For 1957-58 the index was 139.

Israel.—Among the projects recently approved by the Investment Centre of Israel is the extension of the Nesher Cement Works which will cost 7,500,000 dollars.

Sudan.—The formalities for the second cement works in the Sudan, The Nile Co., Ltd., have been completed and arrangements have been made for European and Japanese firms to supply the equipment.

The cement works of the Sudan Portland Cement Co., Ltd., at Atbara, is being extended and by the end of 1961 its production is expected to be at the rate of 180,000 tons a year.

Turkey.—It is reported that 60,000 tons of cement is to be exported to Czechoslovakia.

Iraq.—It is reported that Iraq has sold 120,000 tons of cement to Kuwait.

Middle East.

Ceylon.—The Ceylon Cement Corporation is extending its works at Kakessanturai, near Jaffna, to enable the output to be increased from 80,000 to 230,000 tons per year. A production and distribution centre is being erected at Galle where the capacity of the works will be 100,000 tons per year.

Pakistan.—Three new cement works are to be set up in West Pakistan by private enterprise. They will be situated at Manghopir (Karachi), Gharibwal (Jhelum) and Sang Jani (Rawalpindi).

The second kiln of the Maple Leaf cement works at Daudkhel recently commenced trial production and the total capacity has now increased to 850 tons a day. The kiln was supplied by Czechoslovakia and government sanction is being sought for the installation of a third kiln of 500-tons capacity.

Tenders were recently invited by a Karachi company for the construction of a wet-process cement plant having a capacity of 1000 tons per day and having two kilns each of 500-tons capacity.

Far East.

Formosa.—Owing to reconstruction works and to the damage caused by floods in August 1959, cement was scarce for more than a year. Exports were resumed in August 1960, however, and with increasing production, the export target for 1961 is 400,000 tons.

The Taiwan Cement Corp. produced about 900,000 tons of cement in 1960.

The new Universal Cement Corporation is to establish a works with an annual capacity of 170,000 tons and production is expected to commence in 1962.

China.—An effort is being made to increase the production of cement by the establishment of small works throughout the country, about one thousand of which are already in operation.

Malaya.—It is reported that the total production of cement at the works of the Malayan Cement Co., Ltd., at Rawang, near Kuala Lumpur has now reached 1,000,000 tons. The company is an associated company of the Blue Circle Group. The works at Rawang began operations in July 1953.

Philippines.—The total cement production in the Philippines in 1959 was 716,000 tons compared with 632,000 tons in 1958, it is stated in a recent number of "Pit and Quarry." Five works were in operation and it is expected that thirteen works will be in operation by the end of 1962, the probable total capacity being 1,300,000 tons.

The works of the Universal Cement Co., Inc., at Cebu, which began production in May 1960, will produce about 150,000 tons annually.

Construction of the works of the Mindanao Portland Cement Co. is now proceeding. The works will have an annual capacity of up to 150,000 tons.

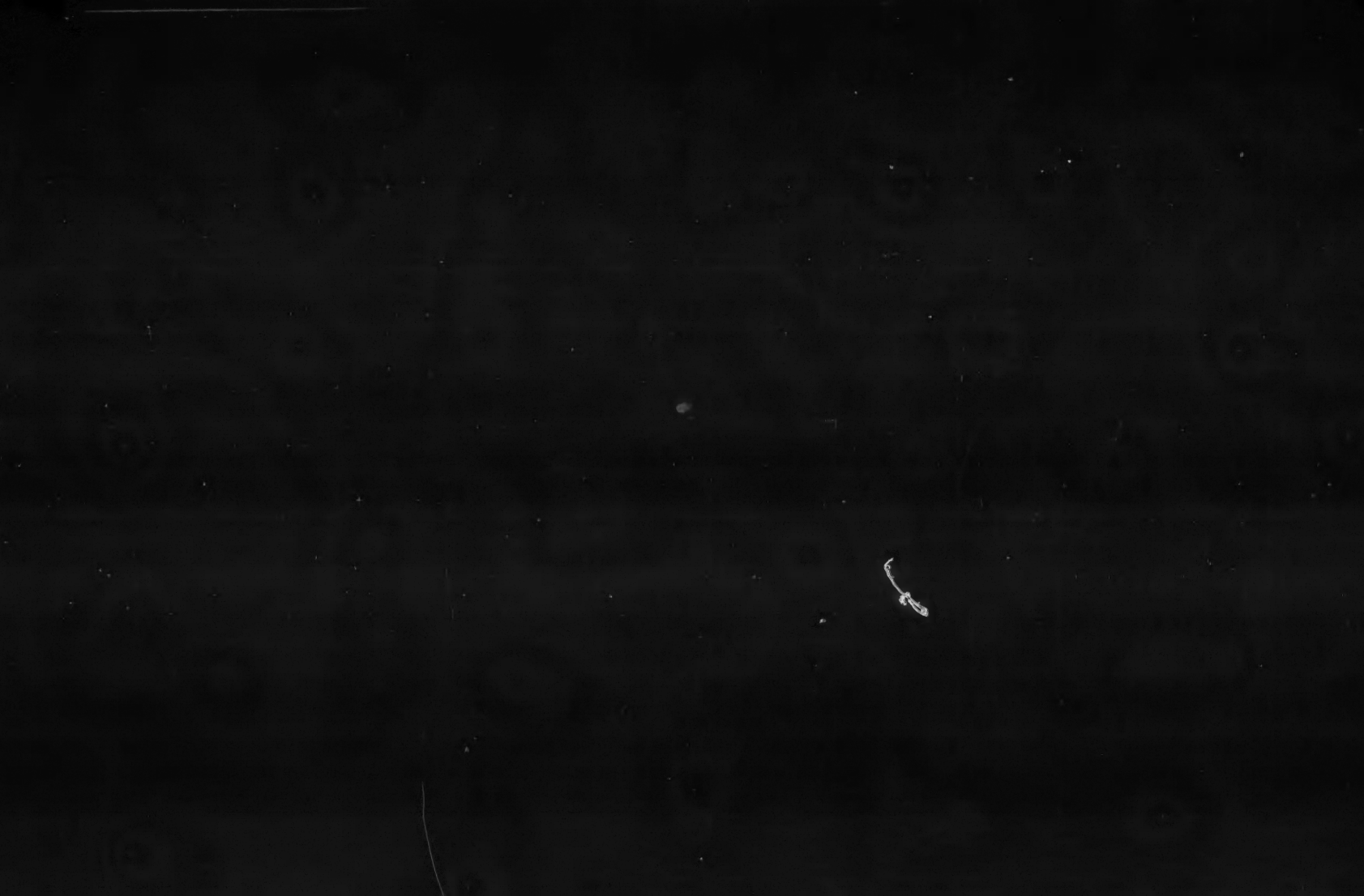
An Oil-fired Lime Kiln.

THE new kiln being installed at the works of the Beswick's Lime Works Ltd., near Buxton, is the first oil-fired kiln in the district. The method of firing, which is said to be unique, is such that fuel is gasified in the kiln itself instead of being cracked in a separate combustion chamber before being fed into the kiln as a gas.

The steel casing of the kiln, which is 72 ft. high, was delivered by road in two sections, each section being 25 ft. long and 10 ft. in diameter. The operation of assembly, which occupied half an hour only, comprised the bolting together of the two sections on the ground and lifting, by means of a crane, the combined unit, weighing 17 tons, into a vertical position on the foundations.

Trade Notice.

Particulars of the apparatus described on page 62 for detecting weaknesses in kiln linings are obtainable from Honeywell Controls, Ltd., Greenford, Middx.



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